Importance of Interincisal Index for Predicting Mesiodistal Crown Diameters of Canines and Premolars

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A B S T R A C T

The aim of this study was to examine the accuracy of regression equation for prediction of the mesiodistal diameter (MDD) of the crowns of canines and premolars (C, P_1, P_2), and to determine whether an incisal indexs can serve as a reliable predictor. MDD and vestibulooral diameter (VOD) of the crowns of central and lateral incisors (I_1, I_2), C, both P_1, and P_2, and first permanent molars (M_1) in both jaws were measured on the plaster casts of 150 subjects (75 boys and 75 girls) The obtained measurements were compared and correlated with predicted values (by linear regression equation derived previously), with respect to gender, jaw side and value of the interincisal index. The correlation coefficients between measurements and predicted MDD of the C, P_1, and P_2 were calculated with respect to gender and jaw. The values varied from 0.62 to 0.81. It could be concluded that normal values of the interincisal index of the I_1 and I_2 are highly associated with measured and predicted MDD of the C, P_1, and P_2 crowns. Correlation coeffitients ranged from 0.84 to 0.99.

Key words: *intericisal index, mesiodistal diameter, canines, premolars*

Introduction

The prediction of mesio-distal diameters (MDD) of unerupted canines and premolars (C, P_1, and P_2) has a great importance in orthodontic diagnosis. Because of X-ray exposure, problems of standardized tubus positioning[1], crown enlargement on X-rays[2,3] and frequent premolar rotation[4], linear regression methods[5–14] are used more frequently than radiological methods alone or a combination of radiological numerical statistical methods[2,3,15–20]. The simple correlation methods of Moyers[7], Tanaka and Johnston[8], Droschl[9] and other authors[5,10] have proved to be inaccurate in different populations[12,21–30], including the Croatian as well[31]. While exploring the suitability of the regression methods of Bachman[11], Gross-Hasund[12] and Trankmann et al.[13] for the Croatian population, it was found that their accuracy was much higher[31]. In one of our previous studies we established linear regression equation for the Croatian population[32], enables to estimate the widths of unerupted canines and premolars in both dental arches for boys and girls by using three to five predictors. The purpose of the present study was to explore the suitability of established prediction models for the Croatian population on a larger sample and to check weather the relation between the MDD of permanent maxillary and mandibular incisors can at start indicate when this method can be used.

Material and Methods

Plaster casts of 150 children (75 boys and 75 girls) aged 14 to 18 years treated in orthodontic clinics in the city of Zagreb, Croatia were examined. The following selection criteria were used: permanent dentition in both jaws; teeth fully erupted to occlusal plane; no obvious

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anomalies regarding number, form, size and structure; intact mesiodistal and vestibulooral surfaces of the crowns; aligned arches to allow relatively easy and consistent measurement. The MDD and vestibulo-oral diameters (VOD) of the I_1, I_2, C, P_1 and P_2 and M_1 were measured on the plaster cast in all four segments. The measurements were made according to the method of Seipel[5] using an electronic digital caliper, 150 mm HS/R3/1A, from Knuth Gmbh + Co., Werkzeugmaschinen KG, with accuracy of 0.01 mm. The measuring surfaces of the digital cliper were narrowed to achieve precise approach to interdental spaces. Before the measurement, the caliper was calibrated at the Faculty of Mechanical Engineering and Naval Architecture of the University in Zagreb. All variables (MDD and VOD of the I_1, I_2, C, P_1 and P_2) were measured twice within a two week period to determine consistency in the measurements (test-retest reliability). The final variables were obtained as arithmetic mean of the two measurement values. The sum of MDD of unerupted C, P_1 and P_2 was determined using the following regression equations:

1) Girls' upper jaw:

$$\text{MDD + C,P}_1\text{,P}_2 \text{ + } = 1.415(\text{MDD 32}) + 0.386(\text{MDD 36}) + 0.398(\text{VOD 31}) - 0.725(\text{VOD 32}) + 0.277(\text{VOD 26}) + 7.80$$

2) Girls' lower jaw:

$$\text{MDD – C,P}_1\text{,P}_2 \text{ + } = 0.916(\text{MDD 32}) + 0.430(\text{MDD 36}) + 0.414(\text{VOD 26}) + 6.28$$

3) Boys' upper jaw:

$$\text{MDD + C, P}_1\text{,P}_2 \text{ + } = 1.003(\text{MDD 32}) + 0.444\text{C,P1,P2} + (\text{MDD 22}) + 0.490(\text{MDD 26}) + 0.385(\text{VOD 26}) + 3.34$$

4) Boys' lower jaw:

$$\text{MDD – C, P}_1\text{,P}_2 \text{ + } = 1.019(\text{MDD 32}) + 0.430(\text{MDD 36}) + 0.497(\text{VOD 32}) + 0.611(\text{MDD 22}) + 3.45$$

The interincisal index was measured as the sums of MDD crowns of all upper and lower permanent incisors. Values ranging from 0.72 to 0.76 were considered normal. The data were statistically evaluated using data analysis software system STATISTICA, version 7.1., StatSoft, Inc. (2005). To test the normality, the Kolmogorov-Smirnov and Lillefor's tests were applied. The normal distribution of variables was checked and the variables were described by means and standard deviations. The analysis of differences was done using Student's t-test or Wilcoxon matched pairs test, where appropriate. Correlation between the variables was presented by Pearson's correlation coefficient r, its squared value r^2 (coefficient of determination, which estimates common variation of the two variables) and the correspondent level of statistical significance, p.

Results

All variables were measured twice, by the same examiner, with a two-week time interval between measurements. The difference between the first and the second measurement was found to be very small, ranging from 0.48 to 0.62%, and consequently the final variable value was determined as arithmetic mean of the two measurements. Mesio-distal (MDD) and vestibulo-oral diameters (VOOD) were measured separately for the left and right side of the jaw (homologous teeth). The differences between values on the left and right side were tested by *t*-test for dependent samples. The analysis revealed no statistically significant differences for both genders. Therefore, arithmetic means were calculated for the purpose of further data analyses. Comparison of the MDD of crowns between the two gender groups, showed that

TABLE 1
VALUES OF MESIODISTAL DIAMETERS OF CROWNS OF HOMOLOGOUS TEETH AND THEIR COMPARISON WITH RESPECT TO GENDER

Homologous teeth	All	Girls	Boys
11 & 21	8.63±0.51	8.53±0.45	8.72±0.55*
12 & 22	6.70±0.60	6.68±0.53	6.72±0.66
13 & 23	7.85±0.45	7.67±0.31	8.03±0.50***
14 & 24	7.04±0.45	6.94±0.39	7.15±0.48**
15 & 25	6.76±0.46	6.65±0.40	6.87±0.49**
16 & 26	10.32±0.61	10.11±0.52	10.52±0.62***
31 & 41	5.37±0.36	5.32±0.35	5.42±0.36
32 & 42	5.94±0.37	5.86±0.33	6.02±0.39**
33 & 43	6.81±0.42	6.59±0.26	7.02±0.43***
34 & 44	7.15±0.42	7.05±0.32	7.24±0.49**
35 & 45	7.26±0.48	7.16±0.43	7.37±0.51**
36 & 46	10.97±0.67	10.78±0.58	11.17±0.69***

* $p<0.05$; ** $p<0.01$; *** $p<0.001$

TABLE 2
VALUES OF VESTIBULOORAL DIAMETERS OF HOMOLOGOUS TEETH AND THEIR COMPARISON WITH RESPECT TO GENDER

Homologous teeth	All	Girls	Boys
11 & 21	7.19±0.56	7.08±0.47	7.30±0.61*
12 & 22	6.40±0.59	6.28±0.51	6.52±0.63**
13 & 23	8.13±0.62	7.89±0.46	8.37±0.67***
14 & 24	9.34±0.65	9.15±0.49	9.52±0.74***
15 & 25	9.46±0.64	9.26±0.48	9.66±0.72***
16 & 26	11.34±0.66	11.11±0.57	11.57±0.66***
31 & 41	6.05±0.46	5.98±0.40	6.13±0.50*
32 & 42	6.29±0.43	6.24±0.35	6.33±0.50
33 & 43	7.36±0.56	7.21±0.41	7.50±0.65***
34 & 44	7.81±0.52	7.60±0.41	8.01±0.54***
35 & 45	8.53±0.54	8.36±0.40	8.70±0.61***
36 & 46	10.59±0.56	10.36±0.46	10.82±0.55***

* $p<0.05$; ** $p<0.01$; *** $p<0.001$

TABLE 3
SUMS OF MESIODISTAL DIAMETERS OF CROWNS OF UPPER AND LOWER INCISORS AND INTERINCISAL INDEX AND THEIR COMPARISON WITH RESPECT TO GENDER

Teeth	All	Girls	Boys
11&21&12&22	30.66±1.98	30.42±1.68	30.89±2.23
31&41&32&42	22.62±1.36	22.37±1.27	22.87±1.40*
Interincisal index	0.74±0.04	0.74±0.03	0.74±0.04

* $p<0.05$

boys had significantly wider MDD of crowns, apart from the case of both lateral upper and both central lower incisors (Table 1). Boys also had significantly wider VOD of crowns than girls, apart from the diameters of both lateral lower incisors (Table 2). Sums of MDD of the upper incisors did not differ significantly with respect to gender, although the sum of MDD of the lower incisors was significantly lower for girls (Table 3). The value of interincisal index (Table 3) for both genders was similar, apart from the fact that in the group of boys the spread of values was greater (due to the greater spread of the sums of diameters of the upper incisors in that group). The values of MDD of the P1 and P2 were calculated using regression equation already established in previous studies. These predicted values were compared with the measured values, which showed no statistically significant differences (Table 4). The correlation between the predicted and measured values was highly significant particulary in the group of boys. Comparison for the lower jaw showed significantly stronger correlation in the group of boys (0.833 *vs.* 0.624, $p=0.006$) although it was not the same for the same comparison in the lower jaw (0.813 *vs.* 0.730, $p=0.216$). From the distribution of the absolute differences in the measured and predicted MDD of the C, P_1 and P_2 values (Table 5) it can be seen that the majority of values (boys 80% in the upper and 82.1% in the lower jaw; girls 90.7% in the upper and 86.6% in the lower jaw) lie in the interval from –1.0 to +1.0 mm. Comparison of the predicted and measured MDD of the C, P_1 and P_2 was also performed with respect to the interincisal index (Table 6). The analysis showed that the calculated and measured values of MDD of C, P_1 and P_2 had strongest correlation in the groups of subjects with interincisal index, ranging from 0.72 to 0.76.

Discussion

The reliability of regression method for prediction of MDD of the C, P_1 and P_2, determined for the Croatian

TABLE 4
COMPARISON OF MEASURED AND PREDICTED VALUES OF SUMS OF MESIODISTAL CROWN DIAMETERS OF CANINE AND PREMOLARS IN UPPER AND LOWER JAW AND CORRELATION BETWEEN MEASURED AND PREDICTED VALUES

Gender	Jaw	MD345 measured	MD345 predicted	r	r^2
Girls	Upper	21.26±0.94	21.19±0.71	0.730***	0.533
	Lower	20.81±0.82	20.87±0.65	0.624***	0.390
Boys	Upper	22.05±1.30	21.95±1.03	0.813***	0.661
	Lower	21.63±1.31	21.64±1.06	0.833***	0.694

MD345 – sum of mesiodistal crown diameters of canine and premolars; r – correlation coefficient; r^2 – squared correlation coefficient (variance explained); *** $p<0.001$

TABLE 5
DISTRIBUTION OF ABSOLUTE DIFFERENCES BETWEEN MEASURED AND PREDICTED VALUES OF MESIODISTAL CROWN DIAMETERS OF CANINE AND PREMOLARS WITH RESPECT TO JAW AND GENDER

Differences between measured and predicted MDD345	Girls				Boys			
	Upper jaw		Lower jaw		Upper jaw		Lower jaw	
	N	%	N	%	N	%	N	%
$-2.0 \le X < -1.5$	1	1.3	0	0.0	0	0.0	2	2.7
$-1.5 \le X < -1.0$	1	1.3	6	8.0	5	6.7	5	6.7
$-1.0 \le X < -0.5$	14	18.7	12	16.0	12	16.0	11	14.7
$-0.5 \le X < 0.0$	16	21.3	21	28.0	18	24.0	21	28.0
$0.0 \le X < 0.5$	24	32.0	22	29.3	17	22.7	17	22.7
$0.5 \le X < 1.0$	14	18.7	10	13.3	13	17.3	14	18.7
$1.0 \le X < 1.5$	4	5.3	3	4.0	9	12.0	4	5.3
$1.5 \le X < 2.0$	1	1.3	1	1.3	1	1.3	1	1.3

MD345 – sum of mesiodistal crown diameters of canine and premolars

TABLE 6
MEASURED AND PREDICTED VALUES OF MESIODISTAL CROWN DIAMETERS OF CANINES AND PREMOLARS IN GROUPS OF INTERINCISAL INDEX WITH RESPECT TO JAW AND GENDER

Gender	Jaw	TI	MD345 measured	MD345 predicted	r	r^2
Girls	Upper	<0.72	21.32±0.83	21.10±0.69*	0.685***	0.470
		0.72–0.76	20.31±1.35	20.58±0.80	0.906*	0.821
		>0.76	21.37±0.91	21.42±0.65	0.720***	0.519
	Lower	<0.72	20.80±0.79	20.74±0.60	0.490**	0.240
		0.72–0.76	20.35±1.34	20.35±0.78	0.991***	0.983
		>0.76	20.91±0.74	21.13±0.61*	0.660***	0.435
Boys	Upper	<0.72	22.36±1.42	22.10±1.20	0.843***	0.711
		0.72–0.76	21.41±1.34	21.40±0.99	0.942**	0.887
		>0.76	21.84±1.11	21.88±0.82	0.717***	0.514
	Lower	<0.72	21.84±1.48	21.73±1.25	0.889***	0.791
		0.72–0.76	20.50±1.01	20.91±1.12	0.844*	0.712
		>0.76	21.61±1.09	21.68±0.79	0.698***	0.487

TI – interincizal index; MD345 – sum of mesiodistal crown diameters of canine and premolars; r – correlation coefficient; r^2 – squared correlation coefficient (variance explained); * $p<0.05$; ** $p<0.01$; *** $p<0.001$

population[32] was examined. The results of the analyses showed high correlations between the measured and predicted values (0.73 for girls and 0.83 for boys in the maxillary and 0.62 for girls and 0.85 for boys in the mandible), indicating the reliability of the method. The method uses three predictors for MDD and three for VOD. Nourlah et al.[27] used four predictors and obtained, correlation from 0.72 in the maxilla to 0.74 in the mandible. The coefficients obtained using the regression equations provided by other authors for the Croatian population, were also lower[31]. Paredes[33] also used four predictors and obtained correlation in the order of 0.81. Other authors used MDD of the crowns as predictors. Bishara et al.[34] found that the differences of MDD of the crowns between populations were smaller than VOD. The study of Otuveni et al.[35] showed that population differences of VOD of crowns were greater for the upper canine and lower central incisor. According to Barnabeu et al.[14], the values of MDD and VOD of crowns were not influenced by the intensity of crowding in the dental arch. In contrast to their findings, Doris et al.[36] reported that MDD of crowns were different, where the difference was based on intensity of crowding in the dental arch. VOD of crowns was used in regression equation by several authors[4,12]. In this study, correlation between the measured and predicted value of MDD of the C, P_1 and P_2 was stronger for the boys. The same findings were also reported by the group of authors analyzing the reliability of eight methods for predicting MDD of the C, P_1 and P_2 for the Croatian population[31]. Again, stronger correlations between the measured and predicted MDD of the C, P_1 and P_2 in boys were found in a study by Panchers et al.[37]. On the contrary, Moorrees et al.[38] and Mietke[6] demonstrated better correlation results in girls. Interincisal index (quotient of MDD of the crowns of upper and lower incisors) can be determined at the age of eight years. According to numerous authors this values can range from 0.60 to 0.100 (Tonn 67–81[39], Hanuschke 60–85[40], Birkenhoven 70–100[41], Schubert 69–80[42]). According to those authors, the mean value of the index ranges from 0.71 to 0.74. In this study, mean value interval was established as ranging from 0.72 to 0.76. Computation of the correlation coefficients between the measured and predicted MDD of the C, P_1 and P_2 for both jaws and genders, showed strong association (correlation coefficients ranging from 0.84 to 0.90) in the group with normal interincisal index. The obtained results show reliable prediction of MDD of the C, P_1 and P_2 in cases with the interincisal index in the normal interval. They are in accordance with results obtained by Paredes et al.[33].

Conclusion

The obtained correlation coefficients between measured and predicted MDD of C, P_1 and P_2 were high and varied from 0.62 to 0.81. Correlations were considerably stronger in the subgroups showing normal values of interincisal index (ranged from 0.72 to 0.76). Interincisal index can serve as an important indicator for reliabile prediction of MDD of nonerupted C, P_1 and P_2 applying regression equation method.

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VAŽNOST INTERINCIZALNOG INDEKSA KOD PREDSKAZIVANJA MEZIODISTALNIH DIJAMETARA KRUNA OČNJAKA I PRETKUTNJAKA

SAŽETAK

Svrha ovog rada bila je ispitati točnost regresijske jednadžbe za predskazivanje meziodistalnih dijametara (MDD) kruna očnjaka i pretkutnjaka (P1,P2) koja je postavljena za hrvatsku populaciju, te utvrditi da li iznos indeksa suma MDD kruna trajnih sjekutića maksile i mandibule može biti pouzdan pokazatelj točnosti njene primjene. Na 150 sadrenih odljeva (75 dječaka i 75 djevojčica) izmjereni su MDD i vestibulooralni promjeri (VOD) kruna centralnih i postraničnih sjekutića, očnjaka, oba pretkutnjaka i prvog trajnog kutnjaka na obje strane u obje čeljusti. Izmjerene vrijednosti MDD kruna C, P_1 i P_2 uspoređene su i korelirane s predviđenim vrijednostima utvrđenih regresijskom jednadžbom u odnosu na spol, čeljust i iznos međučeljusnog sjekutičnog indeksa. Koeficijent korelacije između izmjerenih i predviđenih suma MDD kruna C, P_1 i P_2 utvrđen je u odnosu na spol i čeljust. Njegove vrijednosti kretale su se od 0.62 do 0.81. Može se zaključiti da su normalne vrijednosti indeksa suma MDD kruna I_1 i I_2 obje čeljusti značajno povezane sa izmjerenim i predviđenim sumama MDD kruna C, P_1 i P_2. Vrijednosti spomenutog indeksa koje odstupaju od normale ukazuju da će preciznost predviđanja suma MDD kruna C, P_1 i P_2 regresijskom analizom biti umanjena.